

Sandage versus Hubble on the reality of the expanding universe

Domingos S.L. Soares

Departamento de Física, ICEx, UFMG — C.P. 702
30161-970, Belo Horizonte — Brazil

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*‘We are certainly not to relinquish the evidence of experiments
for the sake of dreams and vain fictions of our own devising.’*

Mathematical Principles of Natural Philosophy,
Book III — I. Newton, 1687

Abstract

A critical reading of Lubin & Sandage’s 2001 paper on the Tolman effect for the reality of the expansion of the universe clearly reveals that Sandage is far from winning the dispute with Hubble on the issue. After all the years, Hubble’s doubt about the reality of the expansion remains as valid as Sandage’s certainty expressed in a series of papers in the last decade.

1 Introduction

To begin with let us state clearly what are Sandage’s and Hubble’s opinions on the reality of the expanding universe.

Since his discovery of the redshift-distance linear relation, Hubble did not accept the direct interpretation of a Doppler effect as being responsible for the spectral shifts. He was still reluctant in accepting the reality of the expansion as late as 1953, the year of his death (Lubin & Sandage 2001, hereafter LS01).

Sandage, on the contrary, mainly based on his and collaborators' long time work on the Tolman effect (in fact, since 1991, see references in LS01), believes that the expansion of the universe is a reality.

Now, LS01's conclusion is rather *inconclusive*, if one sticks to basic concepts of epistemology. After their analysis of the surface brightness (SB) of 34 early-type galaxies is completed, they state, at the end of 4.2: "Therefore, we assert that we have either (1) detected the evolutionary brightening directly from the $\langle SB \rangle$ observations *on the assumption that the Tolman effect exists* or (2) confirmed that the Tolman test for the reality of the expansion is positive, *provided that the theoretical luminosity correction for evolution is real* (emphases added)."

What do they assert anyway? We shall keep for the purposes of the present paper what they write in the abstract: "We conclude that the Tolman surface brightness test is consistent with the expansion to within the *combined* errors of the observed $\langle SB \rangle$ depression and the *theoretical* corrections for luminosity evolution (emphases added)." The effect may be consistent but given the conditional statements it may not exist at all.

On the other side, Hubble's position was much more coherent, from the scientific point of view. Although referred to as "a reductionist bench scientist" (LS01, 1.3), Hubble solely relied (mistakenly, according to Sandage) on the interpretation of his observational data and their accuracy. As far as we know, such a procedure – as regular scientific behavior – was inaugurated by the brilliant Danish astronomer Tycho Brahe, in the XVI century, and has proved wise and successful beyond any doubt. But Sandage adds that besides that *mistake*, Hubble used also a *mistaken* theory of how redshifts should vary with distance. Why, one should ask: how could Hubble use the correct theory if he was, to begin with, looking for the correct theory?

The approach adopted by Sandage in his investigation of the Tolman effect is in fact a masterpiece of *tautology and hermeneutical circularity*, in spite of his clear intention of hiding it (some hints in 2).

In the XXI century, Sandage still plays with q_0 , $H_0 = 50$ and Mattig's equations. When he is warned that his cosmology mates are talking now

about a Lambda-dominated universe, he reduces (a reductionist?) all of the entire new-cosmology standard model to a simple and empty $q_0 = 0$ universe (quoted as “*almost identical*”, see LS01, end of 5).

Cosmology is still a heavy-speculated field in spite of the enormous efforts on presumable cosmology-sensitive observations. In such an environment, scientists are not expected to make incisive statements unless they are supported by definitely secure evidence, both on the theoretical and experimental or observational sides. The paper under criticism is an example of *the uncertain chain that links speculation to speculation in order to confirm speculation*. The scientific procedure is there but the scientific soul is not. In other words, pretty and nice formal science leading to no real scientific conclusion. That is the way LS01 should be read.

2 The Tolman effect

The Tolman (1930) test for the reality of the expansion, in Friedmann-Robertson-Walker universes, predicts a $(1+z)^4$ dependence of the surface brightness with redshift. It is formulated as follows. Consider a source of luminosity L_e at emission, located at comoving distance D , on the time of reception. An observer receives the luminosity $L_e/(1+z)^2$, dimmed by both the redshifted photons and by time dilation on reception. The flux detected by the observer is then given by $F = L_e/[(1+z)^2 4\pi D^2]$.

The observed angular size of the source, with linear size R_e at emission, is $\theta = R_e(1+z)/D$. The average surface brightness is calculated from $\langle SB \rangle = F/(\pi\theta^2) = L_e/[4\pi^2 R_e^2 (1+z)^4] = \langle SB_e \rangle/(1+z)^4$. This can be expressed in magnitudes as $\langle SBM \rangle = \langle SBM_e \rangle + 2.5 \log(1+z)^4$, which is the usual presentation of the Tolman surface brightness test for the reality of the expanding universe.

3 Sandage and collaborators’ inconsistencies

There are a number of inconsistencies in Sandage and co-workers’ approach to the Tolman test. Of course, these are often overlooked by a biased Reader. In their last paper, LS01, the following list shows the main drawbacks in their study.

1) The analysis is made upon a toy model of the universe. A Friedmann model characterized by the deceleration parameter q_0 , a Hubble constant of 50, and the classical Mattig's equations for the dependence of the quantities of interest on the redshift z .

2) Three decisive proofs, presented in LS01, that the expansion is real are everything but *decisive* (see 1.4 and references therein). Two of them, the time dilation test in the light curves of supernovae, and the running of the blackbody radiation as a function of redshift are jeopardized by evolutionary effects, still unsolved. To accept these tests as real tests is left to anybody's wish. The third, namely, the so-called "vertical normalization" of the background Planckian curve is justified by a conversation between Sandage and P.J.E. Peebles, as stated in the acknowledgments. Now, science needs more than *authoritative* discussions as scientific demonstrations. Incidentally, the third proof is considered by LS01 (1.4.3) as the definitive proof of the Tolman effect. One might with reason then ask: why go on further with the investigation?

Speaking of authority, it is worthwhile mentioning two authoritative opinions on the significance of the microwave background radiation in cosmology. Fred Hoyle (2001) states that

"There is no explanation at all of the microwave background in the Big Bang theory. All you can say for the theory is that it permits you to put it in if you want to put it in. So, you look and it is there, so you put it in directly. It isn't an explanation."

And Jean-Claude Pecker (2001) reaffirms:

"Actually, the 3 degree radiation, to me, has not a cosmological value. It is observed in any cosmology: in any cosmology you can predict the 3 degree radiation. So it is a proof of no cosmology at all, if it can be predict of all cosmology."

3) Section 5 of LS01 is dedicated to the tired-light *speculation*, as they put it. To be fair, the discussion presented in this section is useless, from the scientific point of view, since it compares a speculation with a toy model (the Friedmann cosmology). Besides that, "tired light" is in fact the name of a general paradigm: it is still *a paradigm in search of a theory* (note that the same epithet has been already addressed to another speculation, namely,

Guth’s inflation). Being such, there are many possible theories of the tired-light mechanism. It is not clear what theory LS01 considers, which is another weak point of their comparison. By the way, their intention is to compare the tired-light model with *observations*. As shown above, epistemology again teaches us that their approach is not valid.

4) LS01 naturally recognizes that luminosity evolution affects both the observed surface brightness and the absolute magnitude of galaxies. But they make the crucial assumption that it does not affect galaxy radius (3.1). Now, such an assumption is probably not true since the radius is calculated from the Petrossian metric radius, defined as the difference in magnitude between the mean surface brightness averaged over the area interior to a particular radius and the surface brightness at that radius (see 1.5).

5) The calculation of the theoretical luminosity evolution from stellar population synthesis is also plagued with LS01’s naive assumptions. The age as a function of redshift, $T(z)$ (eqs. 8 and 9), is taken from their preferred *toy model*. Of course, Sandage’s stickiness to $H_0 = 50$ is somewhat alleviated here. In his (their) words (4.1): “For these calculations, we must use the *real* value of H_0 (emphasis added).” One should not be surprised to know that his real value of H_0 is 58 km/s Mpc⁻¹.

6) In 4.2, with the evolutionary calculation, they assume overall solar abundances because the metallicities of cluster galaxies are not strongly constrained from the observations. It is well known that different input metallicities onto evolutionary codes lead to substantial different synthesis results.

7) In section 7, they explicitly admit two systematic uncertainties in the study. First, a minor technical problem in the galaxy radius calculation – already contaminated by a major problem, as shown above –, and, second, they acknowledge the selection bias present in the galaxy sample. Anyway, as expected, they assure that “neither of them are severe enough to jeopardize the results.” We may otherwise simply disagree with that.

4 Concluding remarks

As a matter of science, the Tolman surface brightness test for the reality of the expansion of the universe remains inconclusive.

4.1 The contemporaneity of the doubt

Hubble versus Sandage: two antagonized scientific attitudes. Both scientists are confronted with the unknown and their reactions are completely opposite to each other. Why would Sandage's attitude be on the wrong track? Simply because Friedmann models were at Hubble's time as valid as arguing for an still *unknown* behavior of Nature as the cause leading to the redshift-distance relation. As time went by, such an attitude revealed itself to be more and more trustful. Nowadays, one see that modern cosmological models – in fact, modified Friedmann models – are totally unsatisfactory. One of the main desired outcomes of modern cosmology, namely, the matter-energy content of the universe does not conform to the real world: out of the total matter-energy budget only 0.5% is proved to exist from direct observations (see summary in Soares 2002).

One might well ask: how can Sandage and collaborators make so many weak assumptions, in the dangerous terrain of the gravely *unknown*, yet be tolerated by their science mates, and at the end conclude that *something* that is consistent with the expansion model is indeed true, when even the expansion model itself is totally in question because of its definitively wrong matter-energy budget prediction?

Hubble's initial caution would be much more desired, and remains valid today. He had the essential skeptical attitude of a real investigator of Nature.

Today, we must doubt the reality of the expansion because the expansion scenario is part of a cosmological model that has failed in giving a consistent picture of the universe we live.

4.2 Sandage's style

The fragility of Sandage's scientific approach is hidden under an extreme pedagogical style of paper writing. His copious use of scientific references and textbook style confuses rather than convinces the critical Reader.

It is curious – and one is referred here to the realm of psychology – that Sandage does not mention the most likely and scientifically palatable reason for Hubble's reluctance in accepting the expanding universe explanation of his redshift-distance law: *the age problem*. With Hubble's constant of the time, the age of the universe turns out to be about half of the geological age of the Earth. Hubble died in 1953, precisely when Walter Baade made the first

substantial revision of Hubble’s constant. History tells us then that Sandage himself devoted a gigantic effort to put it even down, reaching finally the now famous 50 figure. One might well speculate – in the realm of psychology still – that Sandage does not mention the age problem as the main scientific reason for Hubble’s doubt because he would be revealing his *own personal hell*: he fights also with an age problem – remember, he is a celebrated champion of modern cosmology – and that is the reason of his beloved 50 or lower.

4.3 Last

The age problem, again and again. Where has it led modern Big Bang cosmology to? To *a completely dark and unknown universe*. But, in principle, that is not a big problem at all, as long as one is satisfied with playing with universe toy-models. Exactly the way we witness Sandage and collaborators doing with their investigation of the Tolman effect.

4.4 But not least

A. Brynjolfsson (2006) discussed Lubin and Sandage’s data in the light of plasma redshift theory. He claims that the Tolman test is consistent with plasma redshift cosmology (Brynjolfsson 2004) which predicts that the Tolman factor is close to $(1+z)^3$ and not to $(1+z)^4$, as required by the Big-Bang cosmology. It is worthwhile to reproduce the abstract of Brynjolfsson’s 2006 work mentioned above.

“Surface Brightness Test and Plasma Redshift”

The plasma redshift of photons in a hot sparse plasma follows from basic axioms of physics. It has no adjustable parameters (arXiv:astro-ph/0406437). Both the distance-redshift relation and the magnitude-redshift relation for supernovae and galaxies are well-defined functions of the average electron densities in intergalactic space. We have previously shown that the predictions of the magnitude-redshift relation in plasma- redshift cosmology match well the observed relations for the type Ia supernovae (SNe). No adjustable parameters such as the time variable “dark energy” and “dark matter” are needed. We have also shown that plasma redshift cosmology predicts well the intensity

and black body spectrum of the cosmic microwave background (CMB). Plasma redshift explains also the spectrum below and above the 2.73 K black body CMB, and the X-ray background. In the following, we will show that the good observations and analyses of the relation between surface brightness and redshift for galaxies, as determined by Allan Sandage and Lori M. Lubin in 2001, are well predicted by the plasma redshift. All these relations are inconsistent with cosmic time dilation and the contemporary big-bang cosmology.

C.F. Gallo (2006) presented, in the 2006 April meeting of the American Physical Society, work in progress, in which he discusses a general thermodynamic argument that would justify a “*Tired Light Concept*”. In order to duplicate a Doppler Redshift it is required a detailed microscopic treatment of the photon/light interaction with the interacting medium (plasma, atoms, molecules, negative ions, etc), which has not been conclusively demonstrated theoretically or experimentally yet.

Gallo’s abstract presented at the APS meeting is reproduced below.

“Thermalization Tendency of Electromagnetic Radiation in Transit Through Astrophysical Mediums”

As Electromagnetic Radiation from a hot source transits through a cooler interacting medium, the following are demonstrated from thermodynamic arguments.

- (1) The “hot” radiation always loses some energy to the cooler interacting medium.
 - (2) Detailed behavior depends upon the microscopic nature of the interacting medium.
 - (3) A Redshift will occur, but not necessarily imitate the wavelength dependence of the Doppler Redshift.
 - (4) A Doppler-type redshift will occur only under certain conditions.
 - (5) The loss of radiative energy to the intergalactic medium will contribute to the Cosmic Microwave Background Radiation.
- The following characteristics depend upon the detailed nature of the interacting medium.
- (1) The photon energy loss per collision.
 - (2) The magnitude (cross-sections) of the thermalization process.

- (3) The energy dependence of the cross- section for various mediums.
- (4) Forward propagation characteristics of the Redshifted EM radiation.

Although the effects are small, the cumulative redshift in astrophysical situations can be significant. Earthly experiments are planned.

At this point it is interesting to recall what happened in the past, in a similar situation, when Einstein gave a heuristic interpretation to the *photoelectric effect*. One can make an useful counterpoint to the *redshift effect* observed by Hubble.

Einstein's heuristic model departed from the following experimental evidences (e.g., Stachel 1998):

- (a) the effect does not depend on the intensity of the radiative source;
- (b) short wavelength blackbody radiation is described by the Wien limit;
- (c) large wavelength blackbody radiation is described by the Rayleigh-Jeans distribution.

A heuristic program for the redshift effect might likewise consider at least the following observational evidences:

- (a) the effect depends on the flux of the source according to Hubble's law;
- (b) the effect does not depend on the wavelength of the radiation;
- (c) the effect is quantized (Tifft 2003, Arp 1998 and references therein).

Such a program would certainly clear the way for a theory to the tired-light paradigm.

Turning now to the Microwave Background Radiation (MBR), Halton Arp in one of his books (Arp 1998, p. 237) cites an authentic Fred Hoyle's aphorism:

"A man who falls asleep on the top of a mountain and who awakes in a fog does not think he is looking at the origin of the Universe. He thinks he is in a fog."

Let us then consider a *local* approach to MBR. Being freed from the “prison” of the Hot Big Bang Cosmology one may speculate on an earthly origin for the MBR. Earth’s magnetosphere can be seen as a *magnetic bottle* whose walls are made by solar wind particles trapped along the magnetic lines of the Earth field. A minute fraction of Sun’s light reflected by the Earth surface is caught within such a bottle and is thermalized through Thomson scattering on the bottle walls. The first consequence is that one would expect that the thermalized radiation should exhibit a *dipole anisotropy*, given the nature of Earth’s magnetic field. And that is precisely what was observed by the COBE satellite from its 900-km altitude orbit. A straight consequence – easily testable – is that the background radiation from other “magnetic bottles” – other planets – will be different, with a different thermal spectrum, possibly non thermal and even nonexistent. A probe orbiting another solar system planet like Mars, Venus, etc, would verify the hypothesis. Although WMAP, the *Wilkinson Microwave Anisotropy Probe*, sits far away from Earth, at the Lagrangean L2 point of the Sun-Earth system (see WMAP electronic page at the URL http://map.gsfc.nasa.gov/m_mm/ob_techorbit1.html), which means about 1.5 million km from Earth, that is not enough for it to be released from the magnetic influence from Earth (Figure 1).

Although its large altitude, it is located precisely and deep inside the bullet-shaped magnetopause, which extends to 1000 times the Earth radius or more – approximately 10 million km (see Figure 2 and <http://www-spf.gsfc.nasa.gov/Education/wmpause.html> for more details about the magnetopause).

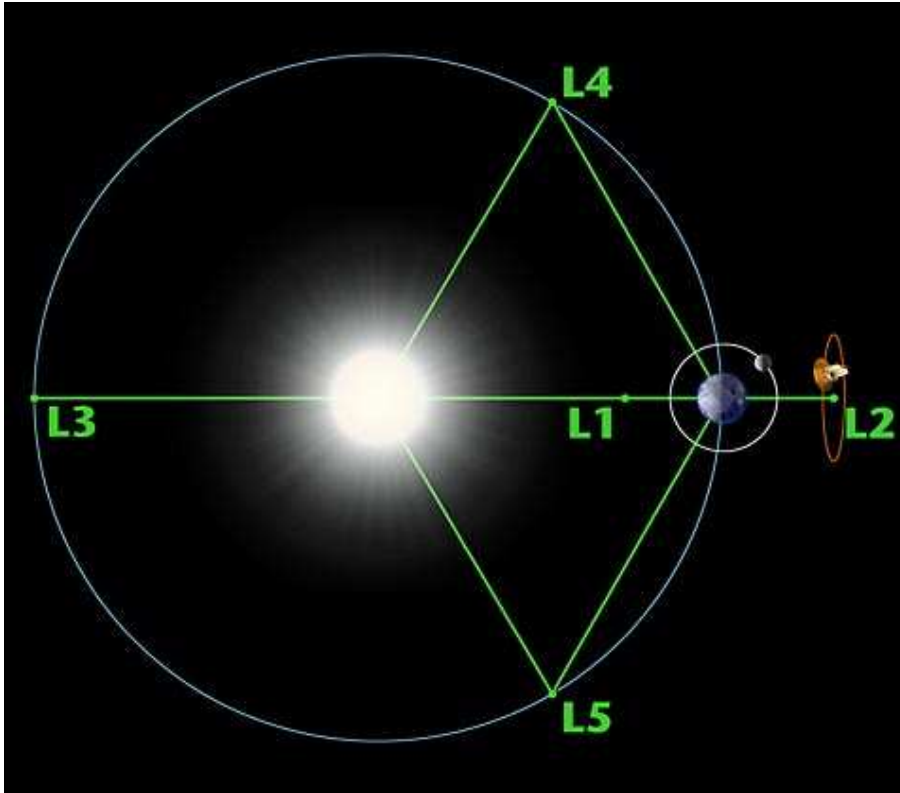


Figure 1: Lagrangean points of the Sun-Earth system. WMAP is shown around L2. Image credit: Wilkinson Microwave Anisotropy Probe electronic page.

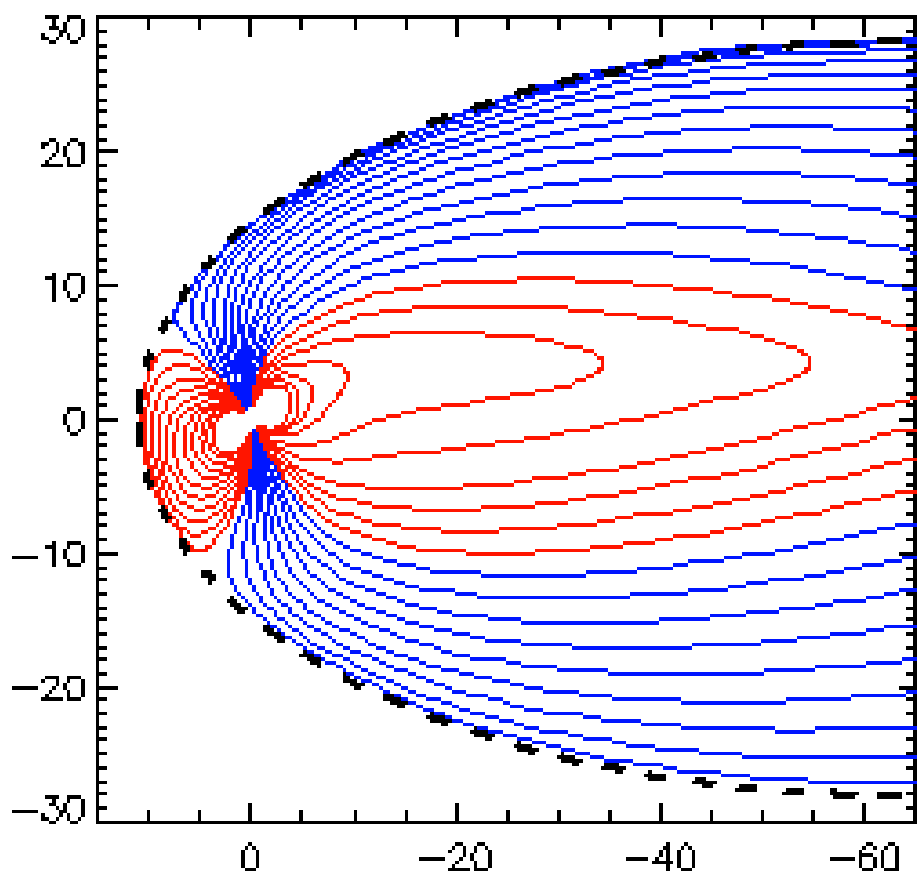


Figure 2: A view of Earth's magnetopause. The bullet-shaped magnetopause is always along the Sun-Earth direction. L2 is inside the magnetopause at about 230 Earth radii. Image credit: "The Exploration of the Earth's Magnetosphere", an educational web site by David P. Stern and Mauricio Peredo.

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